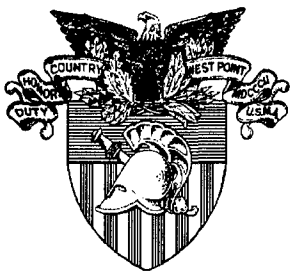

United States Military Academy

West Point, New York 10996

The Army Digital Terrain Catalog II (ADTC)

OPERATIONS RESEARCH CENTER OF EXCELLENCE
TECHNICAL REPORT DSE-R-0602
DTIC #: ADA456501

Lead Analysts

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Assistant Professor and Analyst, Operations Research Center of Excellence

Major Robert R. Keeter, M.S.

Assistant Professor, Department of Systems Engineering

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Assistant Professor, ERDC at Department of Systems Engineering

Lieutenant Colonel Simon R. Goerger, Ph.D.

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Directed by

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This Research was sponsored by: Battle Command, Simulation & Experimentation Directorate

Abstract

Used to improve military effectiveness in responding to emerging threats, enhance warfighting readiness, and reduce operating costs, simulations have become commonplace in nearly all areas of the United States Armed Forces. From material acquisition to force structure analysis, from first-person video-game shooters to network-centric battle staff exercises, simulations have progressed into becoming intrinsic components of nearly all aspects of the military landscape. As the military has become more accustomed to using simulations and its expectations have grown about simulation capabilities, the demand and need for more realistic virtual and constructive environments have increased. Accordingly, there have been escalating demands on the modeling and simulation (M&S) community to incorporate greater fidelity and resolution of the natural and manmade environment and systems interaction in the battlespace to make the simulation experience increasingly more realistic and complete. Unfortunately, this has increased the cost of developing simulations and their associated terrain databases, both in terms of price as well as time. This report documents how the Operations Research Center of Excellence within the Department of Systems Engineering at the United States Military Academy has employed systems engineering principles to help address the rising cost of M&S development. Specifically, this report discusses the design and development of the Army Digital Terrain Catalog (ADTC) to help promote discovery, accessibility, and reuse of digital terrain databases—a key component of M&S that helps drive analysis, acquisition, and training for our Armed Forces. This report also provides a framework that will help identify a suitable host and metadata manager for the ADTC so that the catalog can serve as a way to help promote Army Transformation. The ADTC II is a follow-on project that builds upon the work that Major Grant Martin and Doctor Niki Goerger conducted in 2005.

About the Authors

Dr. Niki C. Goerger, Ph. D., is a research engineer with the U.S. Army Engineer Research and Development Center (ERDC). Her expertise is in the area of physics-based and effects-based representation and quantitative analysis in M&S for military applications. She is currently a research associate at the United States Military Academy and serves there as the Academy's Defense Model and Simulation Office Visiting Professor (M&S) with research tracks in lifecycle acquisition management, M&S and C4ISR interoperability, and physics-based representation in urban operations M&S.

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LTC Simon R. Goerger, Ph. D., is currently serving as an Assistant Professor and the Director of the Operations Research Center of Excellence in the Department of Systems Engineering at the United States Military Academy, West Point, New York. He earned his Bachelor of Science from the United States Military Academy in 1988 and his Masters in Computer Science and Doctorate in Modeling and Simulations from the Naval Postgraduate School, Monterey, CA in 1998 and 2004, respectively. His research interests include combat models, agent based modeling, human factors, and training in virtual environments. LTC Goerger has served as an infantry officer with the 6th Infantry Division in Alaska & Sinai, Egypt, as a cavalry officer with the 2^{d} Armored Cavalry Regiment at Fort Polk, LA & Port-a-Prince, Haiti, and as a software engineer for COMBAT^{XXI}, the US Army's future brigade and below analytical model for the 21st Century.

Acknowledgements

This project was funded under the leadership of Colonel George Stone, III, Director, U.S. Army Battle Command, Simulation, & Experimentation Directorate. The authors would like to acknowledge the following individuals for their enduring contributions: Nancy Gardner, Dan Stevens, Mark Seagrave, David Lashlee, Paul West, Lieutenant Colonel Scott Schutzmeister, and Lieutenant Colonel Favio Lopez. The authors would also like to thank the staff and faculty of the USMA Department of Systems Engineering and members of the M&S community who have helped with the design and implementation of the ADTC. We are indebted to Dave Studnicka, Danny Champion, Major Scott Gilman, Major Mark Tanner, Bruce Robbins, Edgar Barbosa, and Chief Warrant Officer Brendan Kelly for their encouraging feedback, time, and effort in reposing their terrain database entries into the ADTC.

Table of Contents

Chapter 1: Introduction

Soldiers on point for the nation transforming this, the most respected army in the world, into a strategically responsive force that is dominant across the full spectrum of operations . . . The Army's Vision [consists of] People, Readiness, Transformation—and our efforts to change quickly into a more responsive, deployable, agile, versatile, lethal, survivable, and sustainable force.

--Former Army Chief of Staff General Eric Shinseki and former Army Secretary Thomas White

("The 2003 United States Army Posture Statement," letter dated February 11, 2003)

When simulations were first making their way into the military training, analysis, acquisition, and mission planning and rehearsal, much of the M&S development, to include terrain database development capabilities, were decentralized. Decentralization helped to proliferate and indoctrinate M&S within a community of users unfamiliar with simulations and simulation capabilities. Decentralization also helped to promote the use of simulations and facilitated the production of customizable virtual and constructive environments that were more accommodating to the exact needs and specifications of the various military agencies. Unfortunately, the decentralization of M&S development has also led to one critical drawback—a lack of a centralized way for capitalizing upon and leveraging the multitude of simulation terrain databases and models that already exist for various military applications.

Furthermore, although new technologies and vastly increased computing power have resulted in the growth of simulation capabilities and associated terrain database production, such advances in this post-industrial age have also multiplied the military demand for and reliance on simulations [1]. The cost of developing simulation terrain databases—in terms of both price and time—has, therefore, begun to strain available military resources.

One way of reducing production time and costs is to promote reuse of existing resources by publicizing available terrain databases so that potential users can determine fitness for use. In the current environment, however, it is difficult to determine if there exist terrain databases that can be reused or readily modified to meet simulation requirements. A comprehensive inventory of M&S terrain databases in the military does not exist.

To meet this need, the Operations Research Center of Excellence in the Department of Systems Engineering at the United States Military Academy (USMA) has developed the Army Digital Terrain Catalog (ADTC)—a virtual library of metadata records describing terrain databases developed for the military M&S community—as part of a project sponsored by the U.S. Army Battle Command, Simulation, & Experimentation Directorate (BCSE). The ADTC is an information system designed to:

- Inventory existing M&S terrain databases that are in use throughout various military organizations
- Allow military M&S developers to exploit existing terrain databases that have already been developed
- Speed up the use of simulation capabilities by reducing M&S terrain database development time
- Provide military organizations with access to a greater range of realistic M&S terrains that support a variety of scenarios
- Help to better integrate the M&S community

We were asked to determine a means of systematically populating and providing a catalog of digital terrain database metadata records in order to promote greater access, integration, dissemination, interoperability, and exploitation of existing resources, to add records to the catalog, and to recommend a host for its continued growth. The scope of the metadata record gathering and generation effort was principally concerned with supporting the Training

Exercise and Military Operations (TEMO) M&S domain. The effort also included identifying holdings for M&S in the Advanced Concepts Requirements (ACR) and Research, Development, and Acquisition (RDA) M&S domains.

To effectively accomplish our task, however, we realized we would have to deal with a number of issues, including the on-going debate concerning the standardization of geospatial metadata and choosing the most appropriate mechanism for providing the M&S community with access to the ADTC. Using the Systems Engineering and Management Process that we teach to cadets at USMA [2]—a structured problem solving process useful in the design of multidisciplinary, large-scale, and complex engineering problems graphically portrayed in Figure 1—we realized that we were ultimately helping to create an online resource for the military M&S community. We also determined that rather than focusing on resolving which of the competing data standards should be *the standard*, we would quickly deploy the system for the military M&S community to experiment with and use based on a set of accepted standards and best practices. This, in turn, would allow the user-community to largely determine which standards to adopt and implement for the ADTC [3]. We believed this would help to serve two key purposes: 1) to give access immediately to the military M&S community by generating a rapid prototype that would help improve the existing system through quantifiable user feedback, and 2) to permit market forces to largely determine the most appropriate standards by encouraging the community of users to self-regulate how it would exploit and make best use of the ADTC.

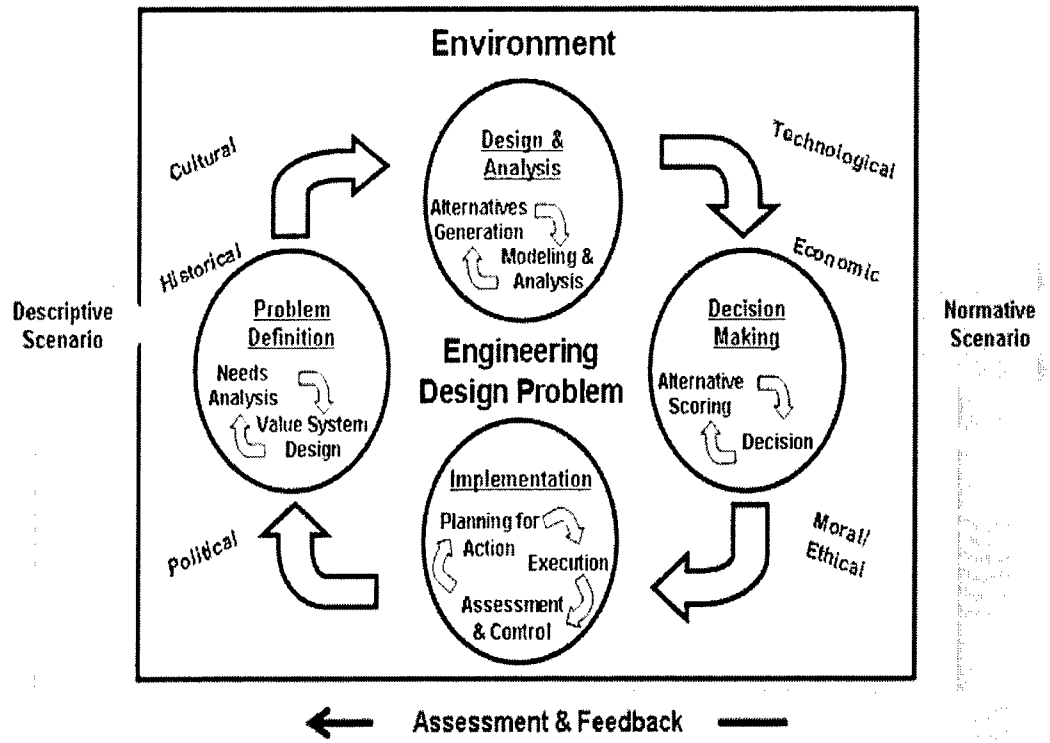


Figure 1: The SEMP Framework

Chapter 2: Stakeholder Analysis

"Usability of interactive computer systems is at the very core of the computer, communications, and information revolution, which is moving our society into the post-industrial era,"

--James Foley

The ADTC II is a follow-on project that builds upon the work that Major Grant Martin and Doctor Niki Goerger conducted on behalf of the Battle, Command, Simulation & Experimentation Directorate in 2005 [4]. While this earlier project, entitled the Army Digital Terrain Library, focused on identifying the most suitable metadata records to include for a centralized collection of M&S terrain databases, the current project has begun the work developing the ADTC and reposing terrain databases into the ADTC.

To help ensure that our design of the ADTC developed into a usable system, we conducted a stakeholder analysis that allowed us to [5]:

- Leverage the opinions, recommendations, and insights of experts in the M&S community on the design of the ADTC
- Generate support from the stakeholders on the direction of the ADTC design
- Gain the support and resources of stakeholders in helping to construct and populate the ADTC
- Foster open line of communications with stakeholders to ensure they understand the intent and goals of the ADTC
- Anticipate stakeholder reaction to the ADTC and periodically redesign the ADTC in a way that is more likely to win their support

The stakeholders who comprise our system consisted not only of our clients, but also of the users and potential beneficiaries of the ADTC. Such stakeholders included representatives of the U.S. Army Battle Command, Simulation, & Experimentation Directorate, Military Simulation Operations Officers, M&S terrain developers from the TEMO, ACR, and RDA domains, M&S users from these three domains, military simulation centers, and simulation planners and coordinators. Likely beneficiaries include military organizations that leverage simulation capabilities, soldiers and leaders who will have greater access to simulations that accommodate their specialized needs, and U.S. taxpayers whose contributions support the national defense.

The team interviewed stakeholders regarding current processes they used, suggestions for moving forward with the ADTC, and needs regarding terrain database development, cataloguing, management, discovery, and reuse. It should also be noted that we also incorporated information gathered from stakeholders concerning metadata needs and preferences for publishers and users

in an earlier project that preceded this work [6]. These informed the problem definition phase of the project.

Chapter 3: Refining the Initial Problem Statement

3.1. The Initial Problem Statement

The initial problem statement involved analyzing and recommending the most appropriate means of systematically populating and managing a virtual terrain database library that would better enable access, integration, dissemination, exploitation, and interoperability for the military M&S community. We were also asked to recommend the most suitable database host for the courses of action that we proposed.

3.2. The Revised Problem Statement

After conducting our stakeholder analysis, we developed that following revised problem statement: We are developing the framework for an online resource on behalf of the M&S community that is able to take advantage of existing capabilities. This resource will provide M&S developers and users with key points of contact and metadata on existing terrain databases that allows them to rapidly screen for fitness of use. A critical component of this resource is the creation of the ADTC which will facilitate the exploitation of existing terrain databases for use in future simulation models.

Chapter 4: A Rapid Prototype Design

In order to ensure our design for the ADTC was continually progressing in the right direction, we decided to build the system as a rapid prototype [7]. Doing so allowed us to

develop a working model that we could promptly change and refine based on the feedback and insights of our expert stakeholders. Figure 2 shows a screenshot of the ADTC homepage which depicts the essential functions of the site—terrain database cataloging, searching, and propagating. Our purpose was not to develop a commercially-hardened, fully-functional system, but to develop a working model that could evolve. Not only did rapid prototyping help to give the stakeholders a means to actually visualize the system, it also helped to improve our own capacity in communicating on how to best modify the system to ensure it would meet the needs and requirements for what we had defined in our revised problem statement. Rapid prototyping, therefore, provided the following benefits:

- Gave stakeholders a way to tangibly evaluate the ADTC
- Empowered stakeholders with a sense that their input would actually play a critical role in the development and refinement of the system
- Allowed us to develop the system without being deterred or fearful that it was simply a working model (imperfect by design)
- Provided us with the ability to swiftly introduce changes to the system based on stakeholder feedback
- Offered us a fairly accurate way to gauge progress and project success
- Presented us with the means to actually build changes into the system without being encumbered by much of the technical complexity associated with M&S

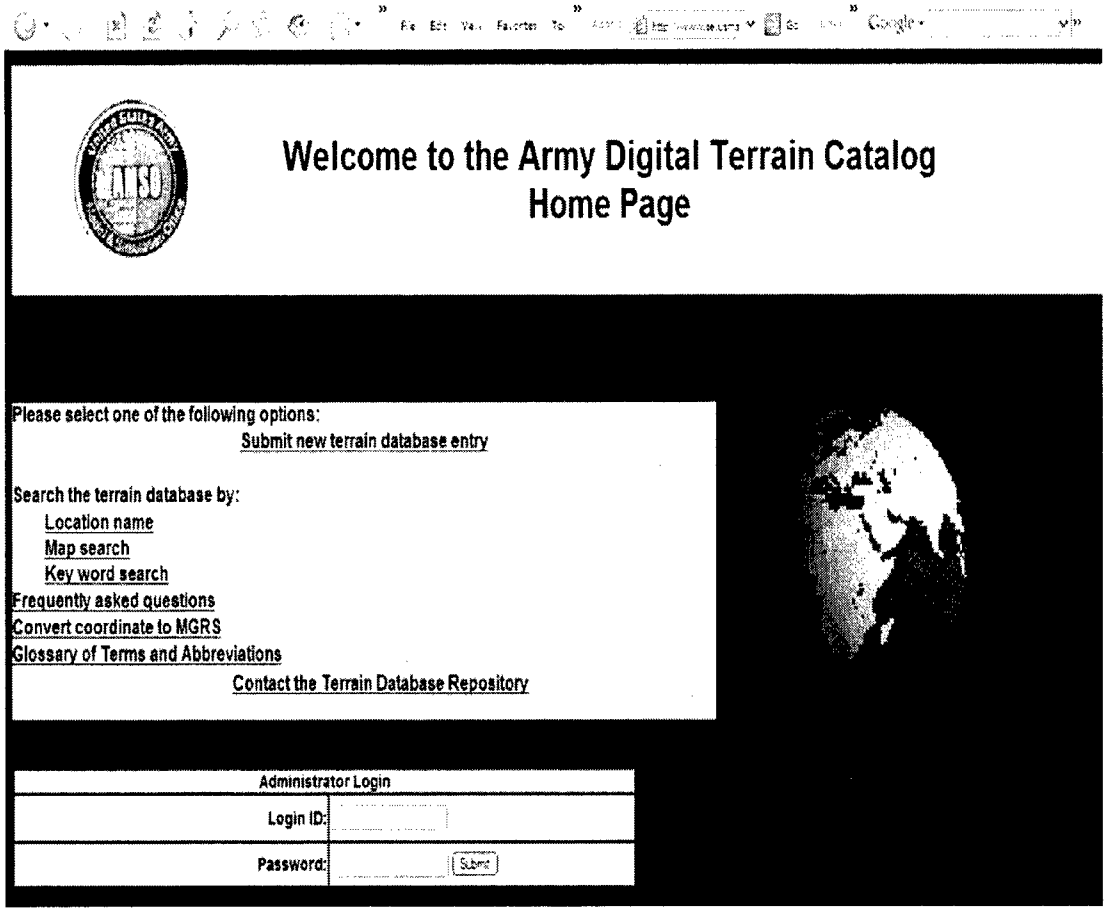


Figure 2: Screenshot of the ADTC Rapid Prototype

Chapter 5: Aligning Product and Process

In order for the ADTC to serve its purpose of being a usable virtual repository of existing simulation terrain databases, we realized that the system had to have the following attributes:

- Consist of appropriate features and descriptors that would enable M&S developers and users to pinpoint the most suitable terrain databases for potential re-use
- Require only the most important features and descriptors so that stakeholders who will populate the database are not too encumbered by the process
- Is intuitive enough for M&S developers to input their terrain databases into the system
- Is comprehensive so that M&S users are able to access and search the repository to locate those terrain databases that best suit their requirements
- Follow naming conventions and general standards accepted by much of the M&S community

- Allow M&S developers to personally define features of their terrain databases that may not be commonly accepted throughout the M&S community

It was evident to us that many of these attributes are at odds with one another and that tradeoffs are apparent. Accordingly, we realized we would need to implement a balanced approach in our design of the ADTC. Deborah Hix and H. R. Hartson advise, "Ensuring usability in an interface requires attention to two main components: the product and the process by which the product is developed" [8]. For this project, the ADTC database and the information stored within it represent the product; the activities required to persuade, encourage, and make it relatively painless for various agencies to input their data into the ADTC represent the process. Figure 3 illustrates our goal of attempting to balance and create greater synergy between the

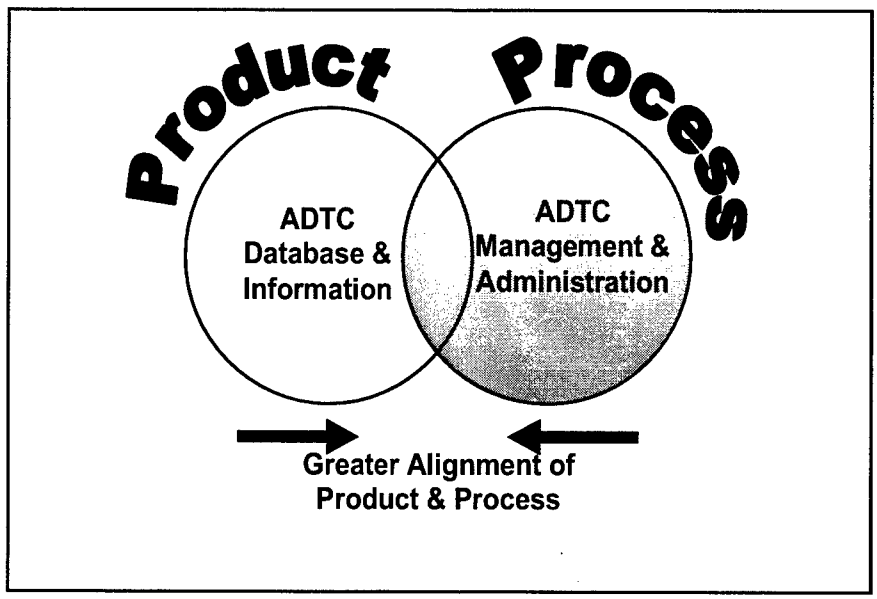


Figure 3: Alignment of Product and Process

database itself and the functions required to ensure the database would be useful. A critical goal in designing this system was the need to demonstrate to the various stakeholders that a better

alignment of product and process will help ensure greater success. Accordingly, we realized we would generate more enthusiasm for the project if we could show that the benefits of the ADTC outweighed the costs associated with it—costs which include time required by M&S developers to populate the system with their terrain databases and a determination and agreement on which metadata entities and attributes to include.

Chapter 6: Metadata Determination

Major Grant Martin and Doctor Niki Goerger's earlier research project which focused on ascertaining the key terrain metadata fields concluded that there should be 21 metadata entries [9]. Our analysis deemed that 20 of these entries should be evenly divided into two groups based on common constructs such as those used in the Department of Defense's Master Environment Library [10]: 1) database identification information and 2) entity and attribute information. The last metadata entry that does not fall into one of the two aforementioned categories is a text field that permits users to post information and comments about a database after they use it.

6.1. The Database Identification Information

The database identification information consists of metadata fields that help to describe the simulation terrain database itself. Such information helps the M&S community quickly categorize what type of terrain database is being examined. Metadata fields that fall into this category are:

- Title of the database
- General description of the database
- Publication date of the database
- Database point of contact
- Email address for the point of contact

- Terrain database coordinates (latitude/longitude)
- Geographic location represented
- Development lineage of the database
- Application of the database (e.g., virtual simulation, constructive simulation, image generation)
- Format and compatibility with other types of simulation models (e.g., OneSAF Testbed Baseline)

6.2. The Entity and Attribute Information

The entity and attribute information consists of metadata fields that help to describe the contents within the simulation terrain database. For the features below, the metadata indicates whether the feature is represented in the terrain database, and if so, the source data used to derive it. Metadata fields that fall into this category are:

- Elevation source data
- Soils representation
- Structure representation
- Cultural feature representation
- Cultural feature source data
- Hydrology representation
- Littoral/coastal feature representation
- Road representation
- Vegetation representation
- Slope surface configuration

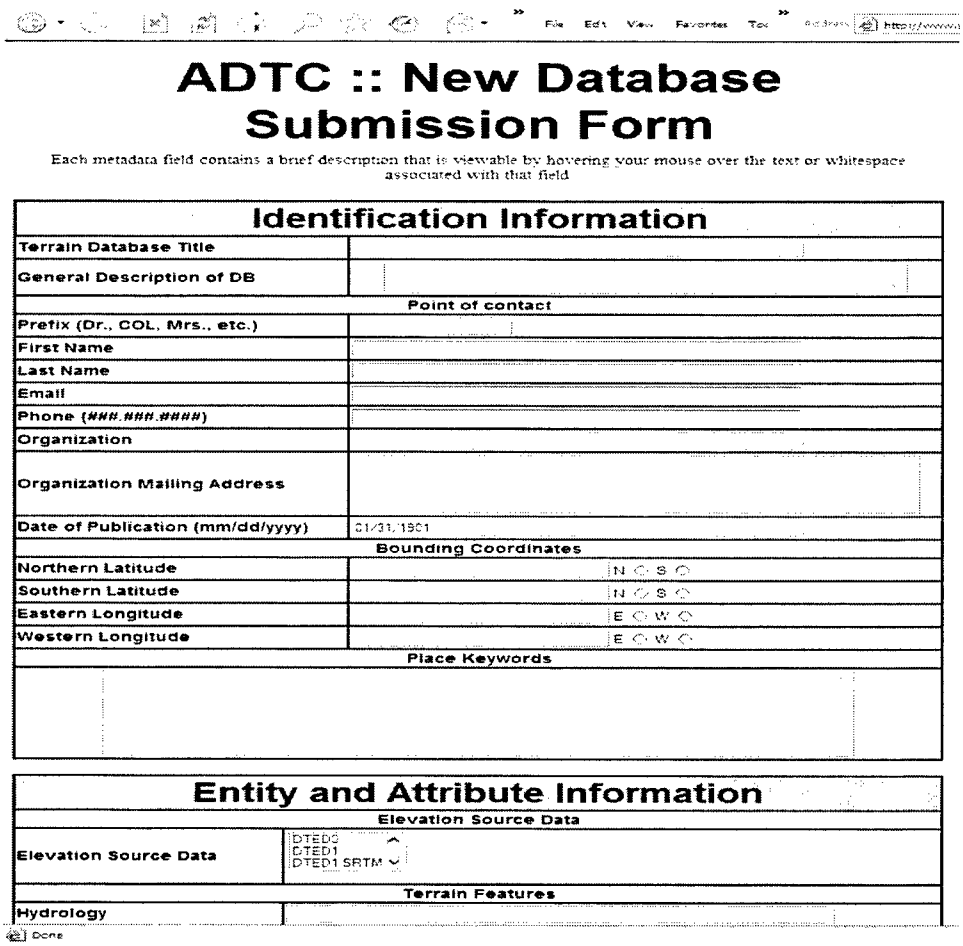
Chapter 7: Design and Development of the ADTC

Success of the ADTC depended on two critical functions: 1) the ease that the system afforded users to populate information on their existing terrain databases, and 2) the simplicity that the system provided users to search for existing terrain databases that matched their needs

and requirements. In order to serve these two functions simultaneously, we designed the ADTC as a dynamic website interface on the front-end with a database system on the back-end. Figure 4 displays a screen capture of the new database submission form. We wanted users to submit information directly into the database as well as search it via an internet web browser without having to know much about databases and database management. This allowed us to capitalize on user familiarity with web browsing functions and permitted us to circumvent having to educate users on manipulating a commercial database program.

We selected Microsoft Access for the database back-end because of its availability, our own familiarity with it, and our knowledge on employing it to interact with a web server. In keeping with our development of a rapid prototype, we also felt it would consume too much time for us to get trained on other commercial database systems. Although we recognize that a number of more sophisticated database systems do exist, the features in Microsoft Access satisfied the needs we envisioned for our prototype design. Furthermore, should our client determine that a more powerful database is required the ADTC can easily migrate into another system.

We selected Dream Weaver MX 2004 as our website development platform primarily because of our familiarity with the program. We initially considered using Microsoft FrontPage but decided against it because it tends to oversimplify functions, thereby limiting flexibility in coding. Dream Weaver MX allowed us to code in .ASP directly and gave us greater freedom to manipulate data without the excessive code that is typically associated with Microsoft FrontPage.



ADTC :: New Database Submission Form

Each metadata field contains a brief description that is viewable by hovering your mouse over the text or whitespace associated with that field

Identification Information	
Terrain Database Title	
General Description of DB	
Point of contact	
Prefix (Dr., COL, Mrs., etc.)	
First Name	
Last Name	
Email	
Phone (###.###.####)	
Organization	
Organization Mailing Address	
Date of Publication (mm/dd/yyyy)	01/31/1901
Bounding Coordinates	
Northern Latitude	N S
Southern Latitude	N S
Eastern Longitude	E W
Western Longitude	E W
Place Keywords	

Entity and Attribute Information	
Elevation Source Data	
Elevation Source Data	DTED0 DTED1 DTED1 SRTM
Terrain Features	
Hydrology	

Done

Figure 4: Screenshot of ADTC Database Entry Request

Rapid prototyping allowed us to run a continual series of beta tests that helped us refine the data fields, naming conventions, and formats we selected for the terrain database attributes and features. The user feedback enabled us to code drop-down menus for certain metadata fields, such as database application and database format, so that we could reduce the variability of user data entries. This helped not only to standardize many of the fields and entries, but also helped to check for record accuracy and completeness. Doing so would also help to make the search feature of the ADTC much more consistent, free of errors, and useful to the user.

In addition to procedural formatting, we also attempted to reduce variability in submission formats by providing as much guidance and information regarding the types and

formats of data that users should enter into each field. These are available at the website's Frequently Asked Questions page, as information balloons over data entry fields, and as parenthetical comments in the submission form itself. The data entry and search results pages were formatted in the same way to help make it easier for users to quickly locate pertinent data and data fields. For instance, the Hydrology entry field is located in the same section of the submission form as the search results form.

We also included multiple search features to permit users to quickly search for relevant terrain databases that would potentially satisfy their M&S requirements. One search method uses interactive maps that permit users to select terrain databases by clicking on visual displays of countries. A second search method is through a key word search. This search checks the title, general description, keywords, and additional remarks fields for possible matches in the database. A third method is through a simple drop-down list of the countries of the world. Finally, the ADTC permits users to simply generate a comprehensive list of all accepted database entries and select terrain databases that fit their particular needs.

We have designed the ADTC to provide a flexible metadata strategy permitting users to customize their search criteria and enhance the prospects of a successful search. We have developed the ADTC as an instrument for the sharing of information on terrain databases. Our intent is to provide the Department of Defense with a tool that helps to optimize the utilization of diminishing resources.

Chapter 8: ADTC Growth and Expansion

As of this writing, there are a total of 495 terrain database entries reposed into the ADTC that users and developers are able to access, search, exploit, and reuse. Table 1 details both the type and the source of these M&S terrain databases. These entries constitute the current core holdings

within the catalog. However, we acknowledge that these core holdings do not constitute an exhaustive inventory of existing M&S terrain databases; there are undoubtedly

Table 1: ADTC Holdings as of April 2006

# of Data-bases	Simulation Types	Organization
13	Joint Conflict and Tactical Simulation (JCATS)	USMA, Systems Engr. Dept. West Point, NY
4	Aviation Combined Arms Tactical Trainer (AVCATT)	PEO STRI (PM CATT), Orlando, FL
11	Close Combat Tactical Trainer (CCTT)	PEO STRI (PM CATT), Orlando, FL
38	JCATS[11], CCTT[4], Meta-VR[23]	III Corps G3, Fort Hood, TX
69	Joint Semi-Automated Forces (JSAF), OneSAF Testbed Baseline (OTB)	Topographic Engineering Center, Alexandria, VA
2	OneSAF Objective System	PEO STRI, Orlando, FL
4	Warfighter's Simulation (WARSIM)	PEO STRI, Orlando, FL
19	Corps Battle Simulation (CBS)	National Simulation Center, Leavenworth, KS
17	Brigade/Battalion Battle Simulation (BBS)	National Simulation Center, Leavenworth, KS
109	JCATS	National Simulation Center, Leavenworth, KS
6	JCATS[1], Joint Theater Level Simulation (JTLS)[5]	US Pacific Command, Camp Smith, HI
100	Combined Arms and Support Task Force Evaluation Model (CASTFOREM)	TRAC WSMR, White Sands Missile Range, NM
85	JCATS[68], Meta-VR[11], JANUS(6)	Joint Multinational Training Command, Germany
18	Meta-VR	Fort Rucker, AL
495	**TOTAL**	

terrain databases that have yet to be accounted for within the ADTC. Consequently, the ADTC will continue to grow until a more complete inventory has been accomplished. Additionally, the development of new terrain databases will contribute to the growth of the ADTC as well. Once the M&S community is able to take advantage of the ADTC, however, we believe the greatest

source of expansion will come from users and developers who are able to make use of the terrain databases reposed within the ADTC. Figure 5 illustrates how the centralized holdings within the ADTC will help to generate not only more but even better terrain databases

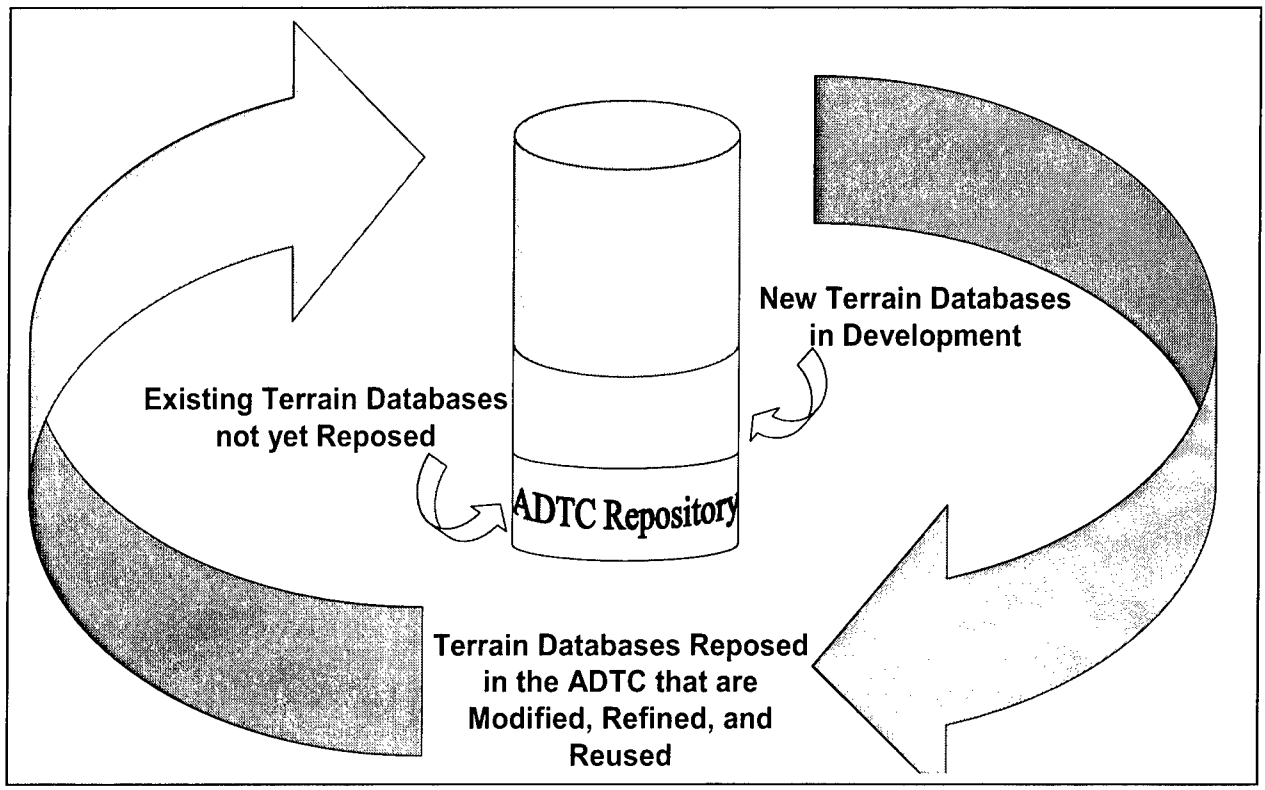


Figure 5: Sources of ADTC Growth and Expansion

for the M&S community. The ADTC will enable users to systematically refine, customize, and modify terrain databases to better and more rapidly suit their particular needs and requirements. A positive Matthew Effect is, therefore, likely to result through the introduction of the ADTC [11]. As more terrain databases enter the ADTC, more terrain databases become available for M&S users to exploit. And the more reuse that occurs because of the ADTC, the more users can newly modified terrain databases into the ADTC.

Chapter 9: Conclusions

According to Foley, "The means of production is less and less the sweat of our brow, or the leveraging of our muscle power with steam or water or electric power, or mindless repetition of work on the assembly line. Rather, the means of production increasingly is the leveraging of our intellectual power with computers" [12]. It is our belief that the work on this project and the development of the ADTC is a way to leverage computational power to make M&S with terrain databases cheaper to develop, more suitable to varying organizational requirements, and more quickly implemented for military training needs. We also believe this project is helping to advance the tenets of Army Transformation. As former Army Chief of Staff General Eric Shinseki and former Army Secretary Thomas White have stated: "Soldiers on point for the nation transforming this, the most respected army in the world, into a strategically responsive force that is dominant across the full spectrum of operations . . . The Army's Vision [consists of] People, Readiness, Transformation—and our efforts to change quickly into a more responsive, deployable, agile, versatile, lethal, survivable, and sustainable force" [13]. Greater use of M&S throughout the Department of Defense is helping to promote military transformation, and our intent is to have the ADTC serve as a key enabler in helping to further advance our military towards the fulfillment of the Army Vision.

Endnotes

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Appendix A: List of Abbreviations

A	
ADTC	Army Digital Terrain Catalog
ACR	Advanced Concepts Requirements
AKO	Army Knowledge Online
AVCATT	Aviation Combined Arms Tactical Trainer
B	
BCSE	U.S. Army Battle Command, Simulation, & Experimentation
BBS	Brigade/Battalion Battle Simulation
C	
CASTFOREM	Combined Arms and Support Task Force Evaluation Model
CBS	Corps Battle Simulation
CCTT	Close Combate Tactical Trainor
D	
DMSO	Defense Modeling and Simulation Office
E	
ERDC	U.S. Army Engineering Research and Development Center
J	
JCATS	Joint Conflict and Tactical Simulation
JSAF	Joint Semi-Automated Forces
JTLS	Joint Theater Level Simulation
M	
MEL	Master Environmental Library
MSRR	Modeling and Simulation Resource Repository
M&S	Modeling and Simulation
O	
ORCEN	Operations Research Center of Excellence
OTB	OneSAF Testbed Baseline
R	
RDA	Research, Development, and Acquisition
S	
SEMP	Systems Engineering and Management Process
SVDR	SNE Virtual Data Repository
T	
TEC	Topographic Engineering Center
TEMO	Training Exercise and Military Operations
U	
USAE	United States Army Engineering
USMA	United States Military Academy
W	
WARSIM	Warfighter's Simulation

*This table is sorted alphabetically

Appendix B: ADTC Holdings

As of April 2006

# of Data-bases	Simulation Types	Organization
13	Joint Conflict and Tactical Simulation (JCATS)	USMA, Systems Engr. Dept. West Point, NY
4	Aviation Combined Arms Tactical Trainer (AVCATT)	PEO STRI (PM CATT), Orlando, FL
11	Close Combat Tactical Trainer (CCTT)	PEO STRI (PM CATT), Orlando, FL
38	JCATS[11], CCTT[4], Meta-VR[23]	III Corps G3, Fort Hood, TX
69	Joint Semi-Automated Forces (JSAF), OneSAF Testbed Baseline (OTB)	Topographic Engineering Center, Alexandria, VA
2	OneSAF Objective System	PEO STRI, Orlando, FL
4	Warfighter's Simulation (WARSIM)	PEO STRI, Orlando, FL
19	Corps Battle Simulation (CBS)	National Simulation Center, Leavenworth, KS
17	Brigade/Battalion Battle Simulation (BBS)	National Simulation Center, Leavenworth, KS
109	JCATS	National Simulation Center, Leavenworth, KS
6	JCATS[1], Joint Theater Level Simulation (JTLS)[5]	US Pacific Command, Camp Smith, HI
100	Combined Arms and Support Task Force Evaluation Model (CASTFOREM)	TRAC WSMR, White Sands Missile Range, NM
85	JCATS[68], Meta-VR[11], JANUS(6)	Joint Multinational Training Command, Germany
18	Meta-VR	Fort Rucker, AL
495	**TOTAL**	

Appendix C: Final Briefing Slides to Client

Presented on 26 April 2005

Army Digital Terrain Catalogue (ADTC), Phase II

Final IPR for COL George Stone, BCSE

presented by the
Operations Research Center
United States Military Academy
26 April 2006

Slide 1

ADTC Project Team

- LTC Simon Goerger, PhD, Director, ORCEN
- Niki C. Goerger, PhD, ERDC at USMA
- MAJ Robb Keeter, USMA
- MAJ Ernie Wong, USMA

Slide 2

Briefing Purpose

- Present results of ADTC, Phase II
- Discuss path forward

Slide 3

Agenda

- Problem Definition
- Products/Deliverables
- Progress & Milestones
- Metadata Enhancement Results
- ADTC Holdings Status
- Hosting Assessment
- ADTC System
- Summary & Path Forward

Slide 4

Problem Definition: Issue

- **Issue:**
  - Terrain database generation costs and timelines are increased by difficulty in identifying and accessing existing terrain databases (TDB) with potential for reuse
  - Next steps toward solution to this problem involve identifying candidate ADTC hosts based on management issues and continuing population of TDBs for the ADTC

Slide 5

Problem Definition: Project Objectives & Scope

- **Objectives**
  - Enhance baseline ADTC metadata and design in terms of supporting user assessment
  - Continue populating ADTC with terrain databases
  - Identify potential ADTC host(s)
  - Conduct cross-walk with Army organizations to synchronize, integrate and avoid redundant efforts where possible regarding populating and maintaining an ADTC
  - Propose an information transfer and services interface for ADTC that greatly facilitates posting, access, and exploitation of existing TDBs
- **Scope:**
  - Select group of M&S platforms (identified with sponsor)
  - M&S systems will include but are not necessarily limited to OneSAF Testbed Baseline, OneSAF Objective System, and Joint Semi-Automated Forces
  - Expected project completion date: March 2006

Slide 6

Products/Deliverables

- **ADTC system that includes**
  - Web design, interface, and search engines for data discovery (search) and publishing linked to a …
  - Dynamic Microsoft Access database ("card catalog") containing terrain databases that is …
  - Architected for hosting on the web
  - Prototype, not commercially hardened
- **Increased ADTC holdings**
- **Refined metadata and structure modifications**
- **Recommendations for hosting ADTC**
  - Host functions differ from metadata management functions
  - Host should provide interfaces and web services; can modify ADTC system or implement their own design

Slide 7

Progress & Milestones

	Milestone	Tentative Dates
✓	Scope problem with client (systems on which to focus)	September 2005
✓	Develop focus and brainstorming questions for needs analysis	September 2005
✓	Identify stakeholders for catalog storage and potential usability study	September 2005
✓	Conduct needs analysis with stakeholders	October 2005
✓	Identify elements of terrain databases catalog storage location that make them unique	October 2005
✓	Develop initial user interface design to input terrain database information and search catalog for entri	November 2005
✓	Conduct a limited data call of existing and developing terrain databases for assessment and testing of metadata and interface usability	November 2005
✓	Recommend ADTC metadata and structure modifications based on database population exercises	December 2005
✓	Develop alternatives for ADTC hosting	December 2005
✓	Conduct IPR with BCSE to review current inventory and research to date	January 2006
✓	Develop prioritized list of locations for TDB population	January 2006
✓	Develop a recommendation for the framework for hosting ADTC / managing terrain database records	March 2006
•	Conduct final briefing with BCSE with recommendations for ADTC hosting and maintenance	March 2006

Slide 8

ADTC Metadata Results

- **Objective: Enhance baseline ADTC metadata and design in terms of supporting user assessment**
- **Accomplishments:**
  - Reviewed phase I recommended metadata and survey comments
  - Followed up with community SMEs for clarification and suggestions
  - Performed cross-walk, revised metadata, and proposed structure based on existing standards to include those in
    - Federal Geographic Data Committee Content Standard for Digital Geospatial Metadata FGDC-STD-001-1998;
    - SEDRIS
    - Technical papers and documents
  - Utilized authoritative definitions and descriptions
  - Garnered feedback from SMEs on enhancements/revisions

Slide 9

ADTC Metadata Results (2)

- **Original Metadata had 9 required entries:**
  - Coordinate system
  - Format
  - Location
  - Are roads represented
  - Is vegetation represented
  - Elevation source data
  - Point of Contact
  - Topography representation
  - Application

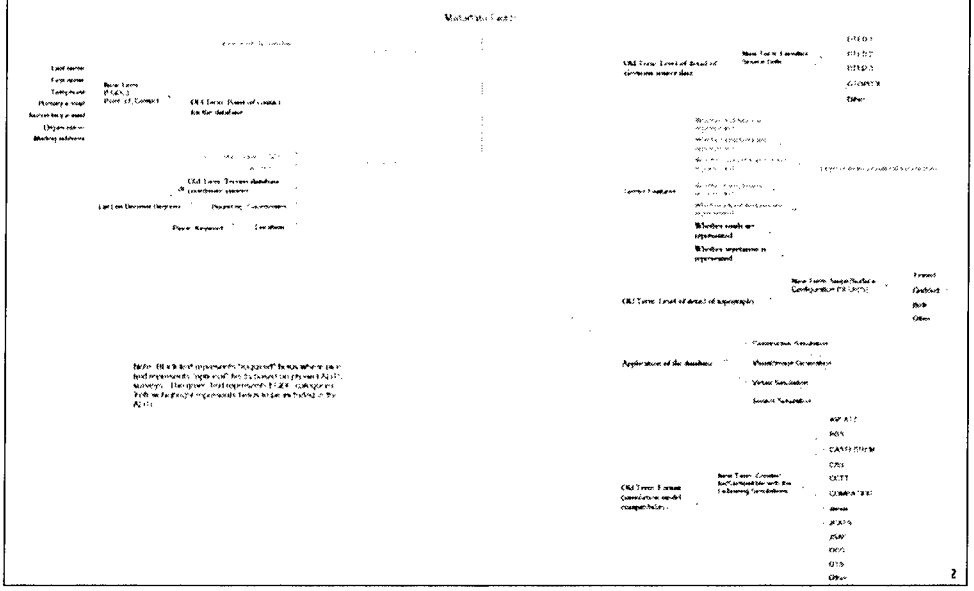
Slide 10

ADTC Metadata Results (3)

- **Original Metadata had 9 optional entries :**
  - Are structures represented
  - Publication date
  - Are cultural features represented
  - Is hydrology represented
  - Cultural source data
  - Are soil types represented
  - Are littoral features represented
  - Lineage
  - Title

Slide 11

ADTC Metadata Results (4)

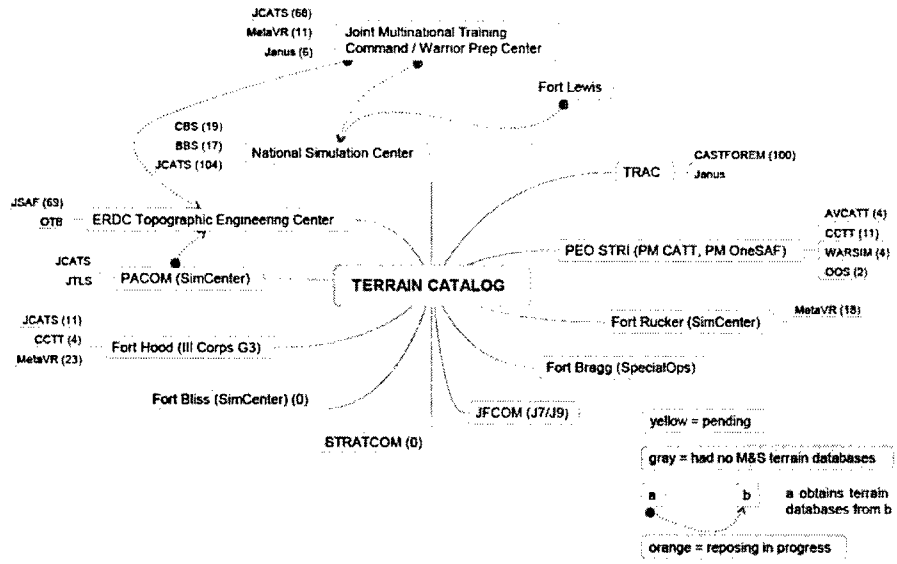


ADTC Holdings Status

# of Terrain Databases Records Obtained	# Reposed in ADTC System	Simulation Types	Organization	Point of Contact
13		JCATS	USMA, DSE, West Point, NY	MAJ Tom Rippert
4	4	AVCATT	PEO STRI (PM CATT), Orlando, FL	Sandy Veautour/Richard Deakins
11	11	CCTT	PEO STRI (PM CATT), Orlando, FL	Sandy Veautour
38	34	JCATS(11), CCTT(4), Meta-VR(23)	III Corps G3, Fort Hood, TX	Art Kowalkowski
69	47	JSAF, OneSAF Testbed Baseline (OTB)	Topographic Engineering Center, Alexandria, VA	Nancy Gardner
2	2	OneSAF Objective System	PEO STRI, Orlando, FL	Bruce Robbins
4	4	WARSIM	PEO STRI, Orlando, FL	Edgar Barbosa
19	19	CBS	National Simulation Center, Leavenworth, KS	Dave Studnicka
17	17	BBS	National Simulation Center, Leavenworth, KS	Dave Studnicka
109	109	JCATS	National Simulation Center, Leavenworth, KS	Dave Studnicka
6	6	JCATS(1), JTLS(5)	US Pacific Command, Camp Smith, HI	MAJ Mark Tanner
100	94	CASTFOREM	TRAC WSMR,White Sands Missile Range, NM	Danny Champion
85		JCATS(68), Meta VR(11), JANUS(6)	Joint Multinational Training Command, Germany	MAJ Scott Gilman
0		TBD by Bliss - not yet decided	Fort Bliss, TX	Dallas Bash
0		TBD JANUS	TRAC WSMR,White Sands Missile Range, NM	Susan Galloway
0		TBD	USMA, GEnE, West Point, NY	CPT Chris Oxendine
18	18		Fort Rucker, AL	CW4 Brendan Kelly
0		they do not have M&S TDBs for ADTC	STRATCOM, Omaha, NE	LTC Larry S. Fellows
495	365	TOTAL		

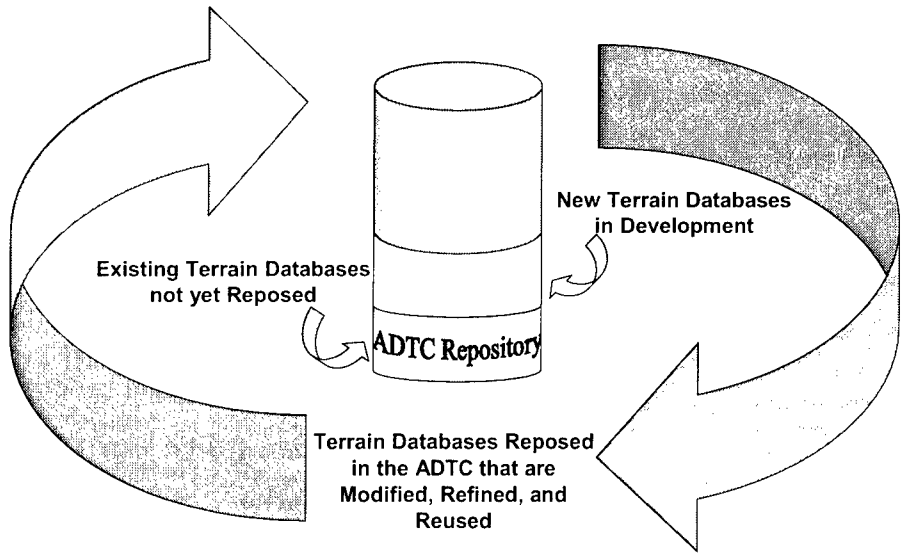
Slide 13

ADTC Holdings (2)



Slide 14

ADTC Growth



Slide 15

Host Alternatives

- AKO
- Geospatial Portal
- MEL
- MSRR
- SVDR/JRD3E

Slide 16

Host vs. Metadata Manager

Host Responsibilities

- Provides shared server & physical hosting
- Promotes discovery & use of the site
- Facilitates ease of interface with database
- Provides security & information assurance
- Communicates helpdesk duties & maintenance roles (administration & support)
- Facilitates installation, configuration, & integration testing
- Articulates & executes plan for contingencies, outages, & technology upgrades
- Has overall responsibility for all software applications (database & interface)

Metadata Manager Responsibilities

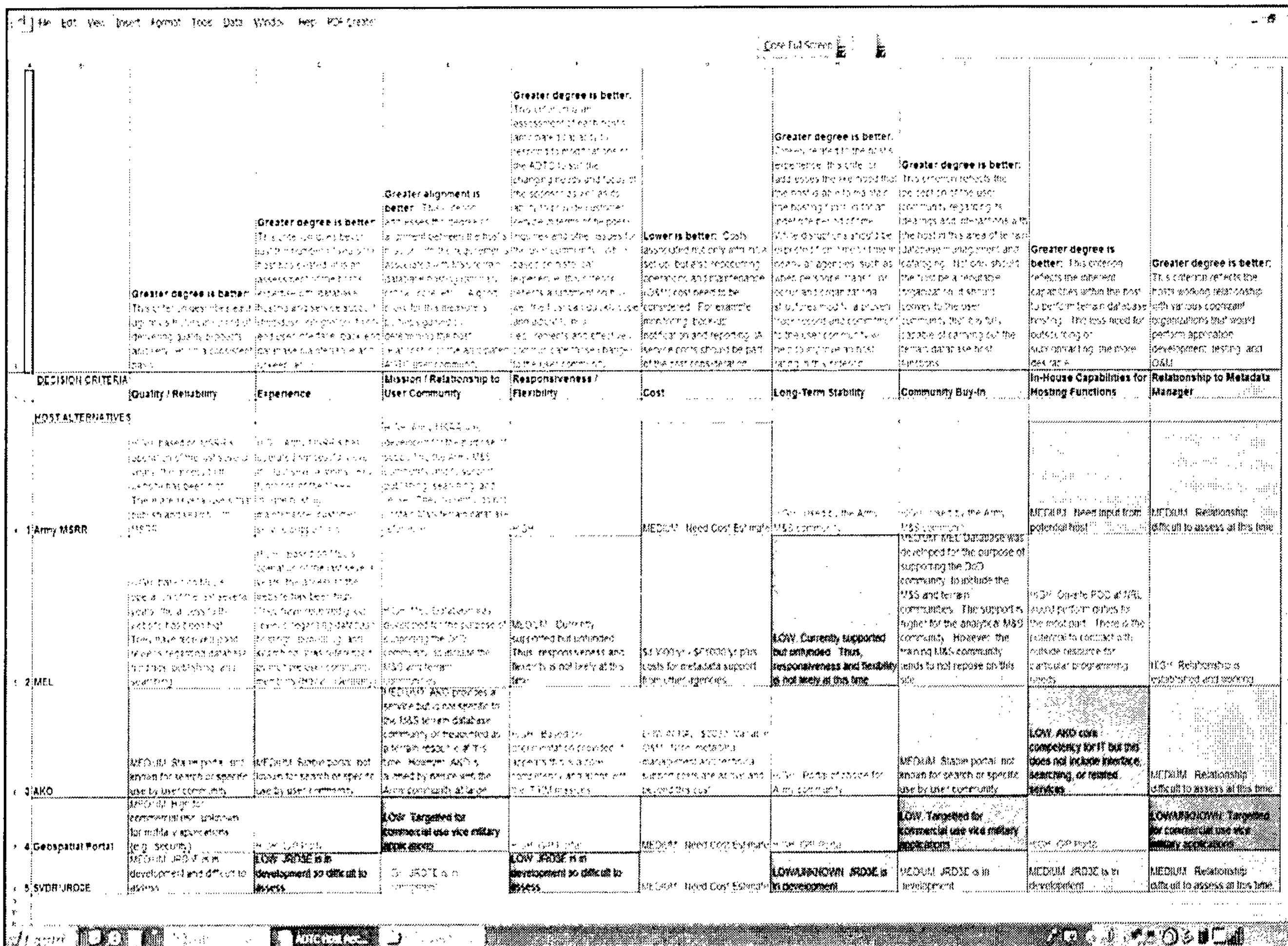
- Maintains, tests, & manages database accuracy & functionality
- Coordinates with host for access levels into database
- Structures agreements with host & complies with host policies & procedures
- Conducts the operations & maintenance of the database
- Responds to informational issues regarding the database
- Accepts, updates, corrects, & modifies database records (push & pull)
- Has overall responsibility for database system

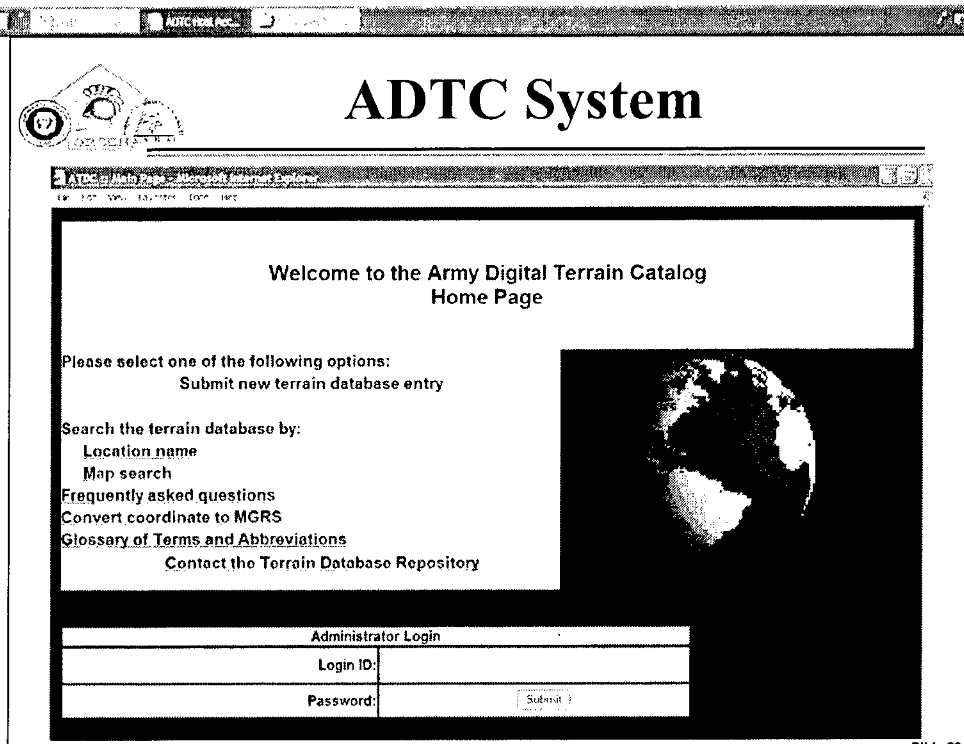
Slide 17

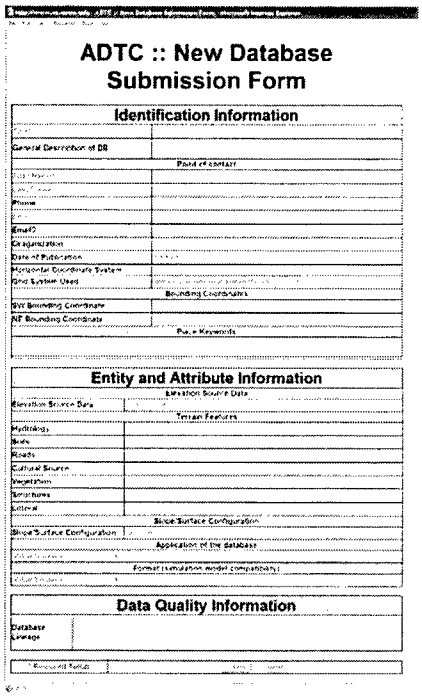
Hosting Evaluation Criteria

- **Quality / Reliability**
- **Experience**
- **Mission / Relationship to User Community**
- **Responsiveness / Flexibility**
- **Cost**
- **Long-Term Stability**
- **Community Buy-In**
- **In-House Capabilities for Hosting Functions**
- **Relationship to Metadata Manager**

Slide 18

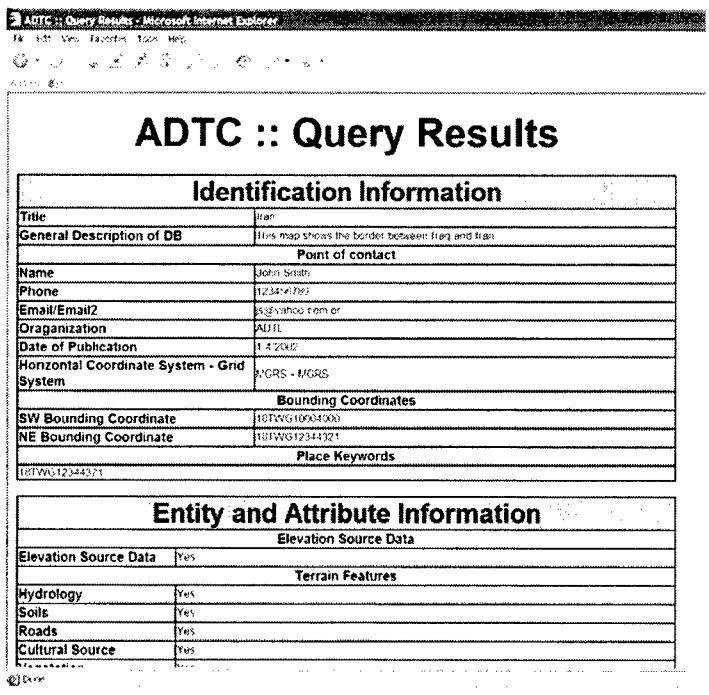

DECISION CRITERIA
Quality / Reliability
Experience
Mission / Relationship to User Community
Responsiveness / Flexibility
Cost
Long-Term Stability
Community Buy-In
In-House Capabilities for Hosting Functions
Relationship to Metadata Manager
HOST ALTERNATIVES
1 Army MSRR
2 MEL
3 AKO
4 Geospatial Portal
5 SVDR/JRDSE
Greater degree is better.
Greater alignment is better.
Lower is better.
LOW: Currently supported but unfunded. Thus, responsiveness and flexibility is not likely at this time
LOW: AKO core competency for IT but this does not include interface, searching, or related services.
LOW: Targeted for commercial use vice military applications
LOW: JRDSE is in development so difficult to assess
LOW/UNKNOWN: JRDSE is in development
MEDIUM: Need Cost Estimate
MEDIUM: Relationship difficult to assess at this time


ADTC System
Welcome to the Army Digital Terrain Catalog
Home Page
Please select one of the following options:
Submit new terrain database entry
Search the terrain database by:
Location name
Map search
Frequently asked questions
Convert coordinate to MGRS
Glossary of Terms and Abbreviations
Contact the Terrain Database Repository
Administrator Login
Login ID:
Password:
Submit
Slide 20



- All fields are designed to conform to Metadata standards.
- Form uses dropdown menus and textboxes with data validation to reduce input error.

Slide 21



Slide 22

ADTC :: Admin Review/Acceptance Form

Identification Information		
Title		Click to Accept
General Description of DB		Click to Delete
Point of contact		
Name		
Phone		
Email:Email2		
Oraganization		
Date of Publication		
Horizontal Coordinate System - Grid System		
Bounding Coordinates		
SW Bounding Coordinate		
NE Bounding Coordinate		
Place Keywords		

Entity and Attribute Information	
Elevation Source Data	
Elevation Source Data	
Terrain Features	
Hydrology	
Soils	

Slide 23

Summary

- **Increased terrain database metadata records to 495 upon completion**
- **Developed an information transfer and services interface for ADTC that greatly facilitates posting, access, and exploitation of existing TDBs**
- **Provided framework for ADTC hosting with initial assessments**
- **Produced an automated CTDB terrain database metadata reader with a mySQL database**
  - Created by Paul West as a "something extra"
  - Metadata reader is in Java which is portable to most platforms and operating systems

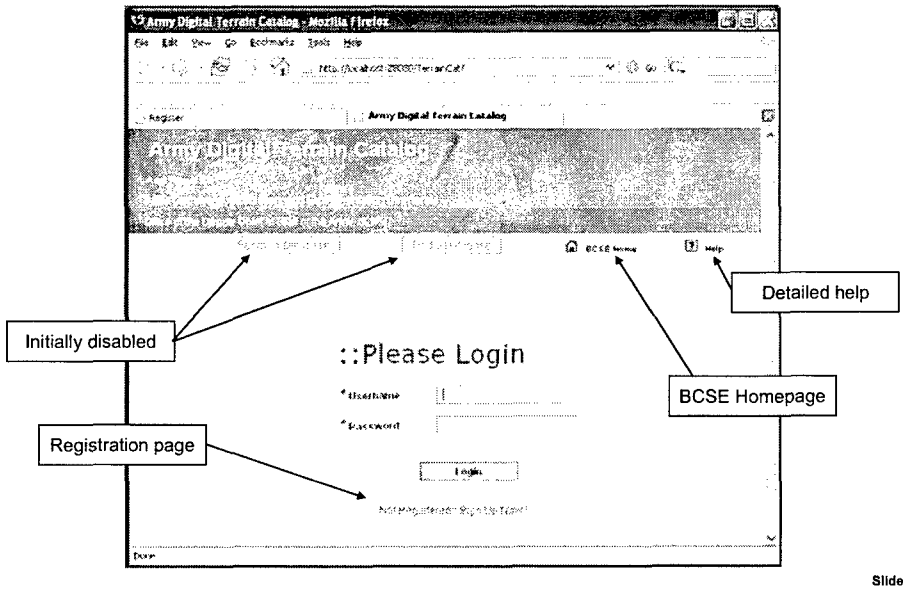
Slide 24

TerrainCat Key Considerations

- **Must be easy to use**
  - Large return for little or no effort
- **Must be accurate**
  - A single human keystroke is a possible error
- **Must be complete**
  - Must support queries on *any* metadata within a compiled database
- **Must link to enterprise-level database**

Slide 25

Login Page



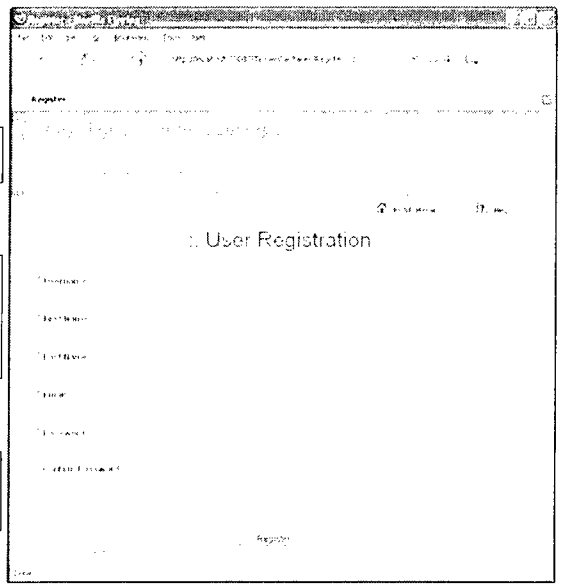
Slide 26

Draft Registration Page

One-time registration

Associates developers with databases for acquisition requests

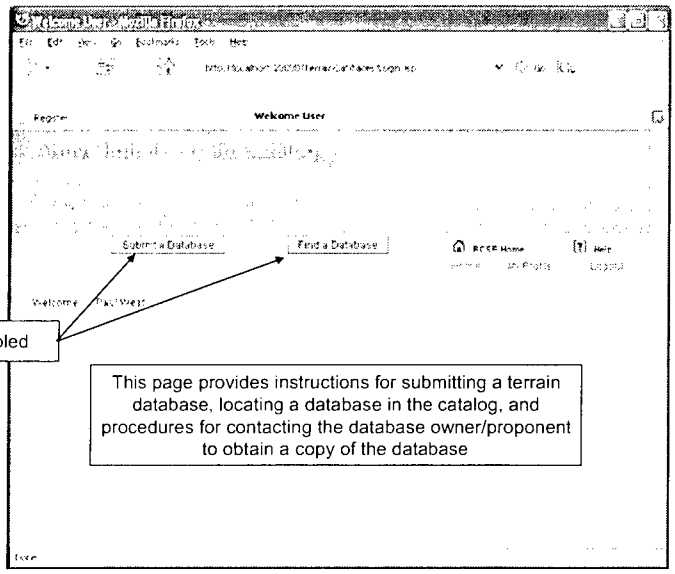
Data is secure and stored in the terrain catalog



Other relevant information (phone, organization, etc) will be requested here (future work)

Slide 27

Instruction Page

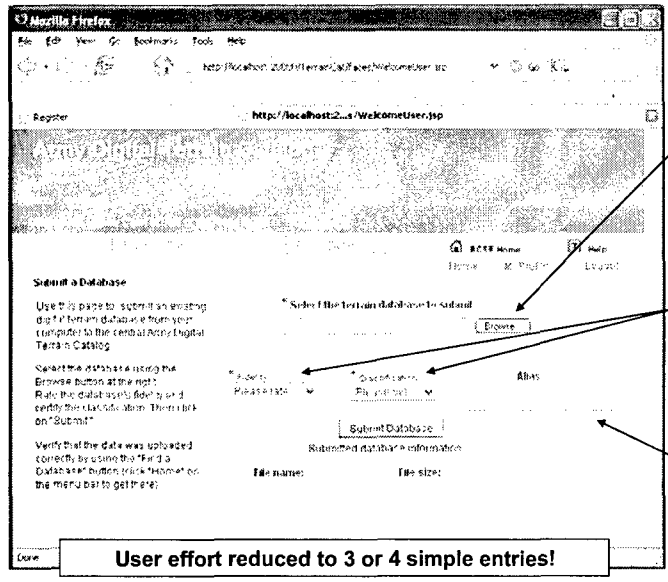


Now enabled

This page provides instructions for submitting a terrain database, locating a database in the catalog, and procedures for contacting the database owner/proponent to obtain a copy of the database

Slide 28

Submit Database Page



Specific instructions for this page

Launches standard file browser on the client

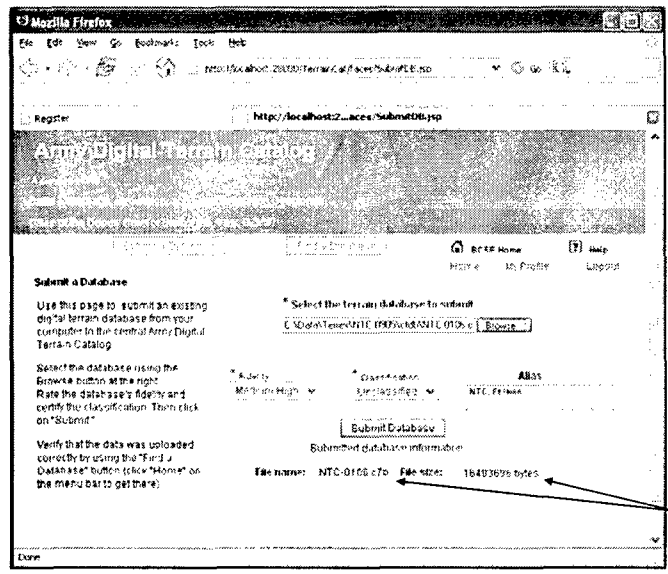
Fidelity, Classification are required

Alias optional but useful for locator

User effort reduced to 3 or 4 simple entries!

Slide 29

Submit Complete



Terrain file is read by file type-specific module and written to the catalog

c7b and c7l file reader is complete

Verification when upload is complete

Slide 30

Metadata Cataloged

One time entry — Provided by the user during registration

- Name
- Organization
- Phone number(s)
- Email and Mailing address

Web-based GUI — Provided by the user during submission

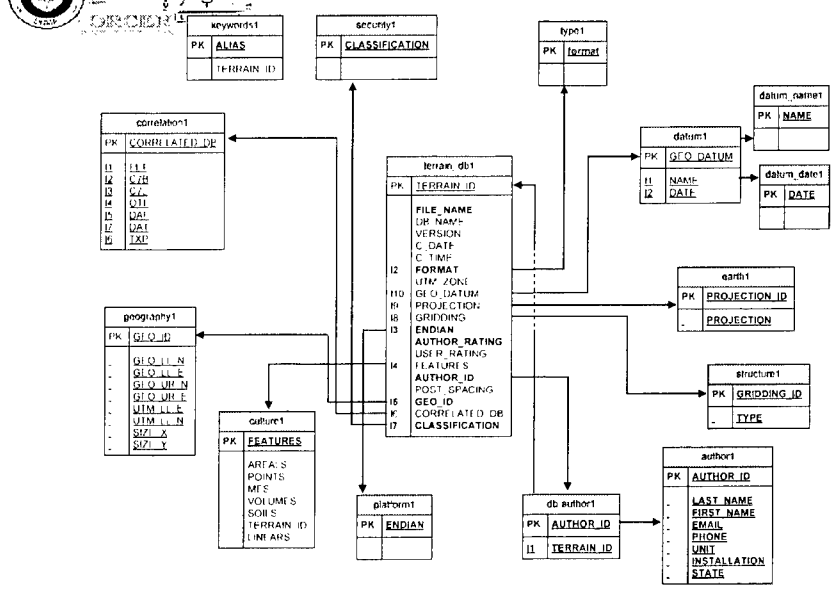
- Fidelity assessment
- Classification
- Database for reading
- Aliases (optional)

Terrain reader currently reads c7b and c7l files — Provided by the terrain file

- File type
- Version
- Creation date and time
- Endian (big / little)
- Geodetic origin
- UTM origin
- Database size (meters)
- Number of areals
- Number of water tables
- Terrain name
- Format (ie 7 for c7b)
- Gridding (tin, gridded, both)
- Post spacing (resolution)
- Datum
- UTM zone
- Number of linears
- Number of soil tables
- Number of MES

Slide 31

Draft Database Structure



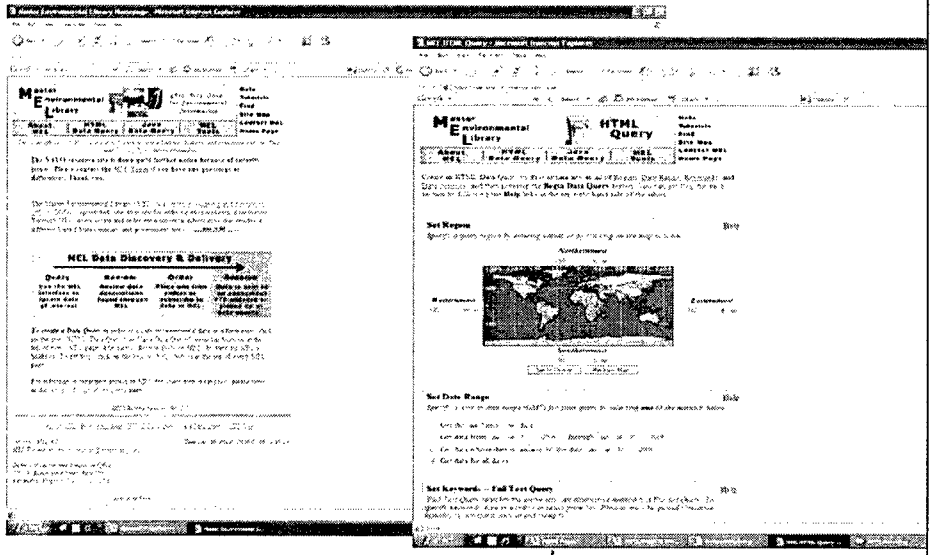
Slide 32

Path Forward

- **Complete reposing and conduct verification of ADTC records**
- **WMSCI paper (Jul 06) and technical report (May 06)**
- **Potential further development of automated readers and database to facilitate rapid growth of ADTC**
  - Can be integrated with St. Cyr cadet project Fall AY07 and potential cadet capstone in addition to analyst project
- **Other?**

Slide 33

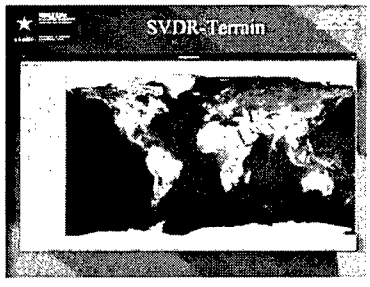
MEL

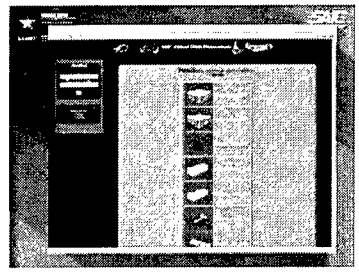


https://mel.dmso.mil/

Slide 34

SVDR (JRD3E)





http://www.sedris.org/stc/2004_pp/repository/js/sld001.htm

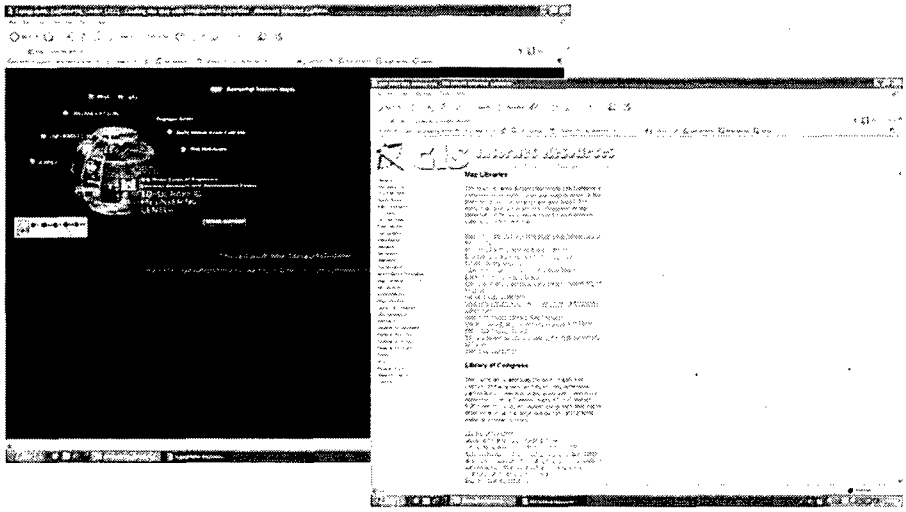
Slide 35

MSRR

http://www.msrr.army.mil/

Slide 36

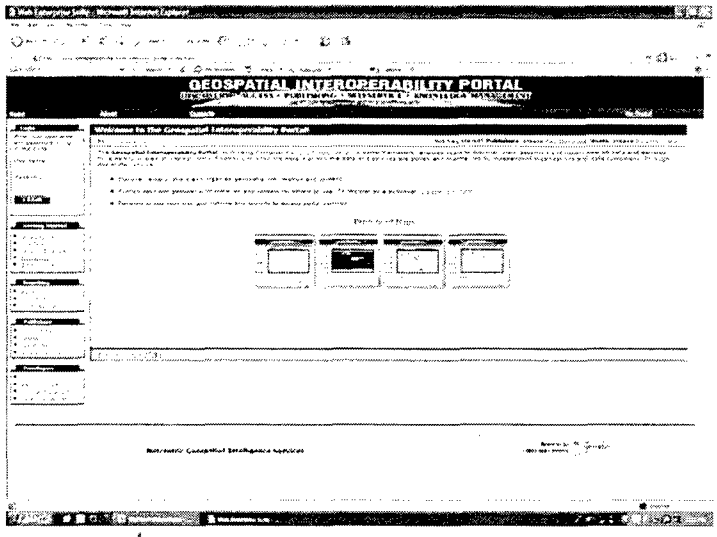
USAE TEC



http://www.tec.army.mil/

Slide 37

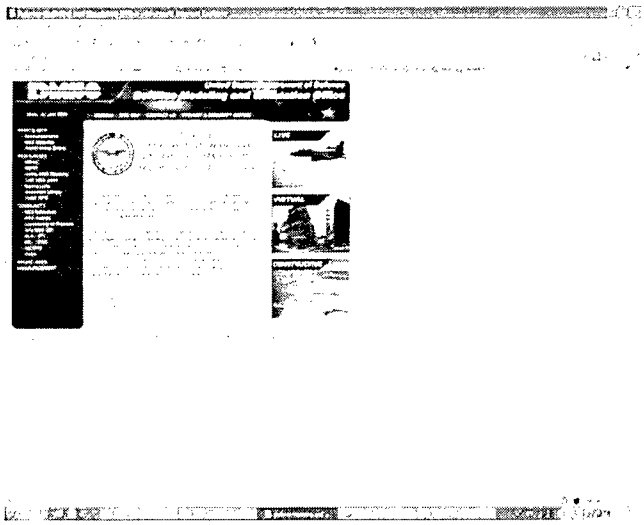
Geospatial Interoperability Portal



http://www.geospatialportal.com/weswww/portal/index.html

Slide 38

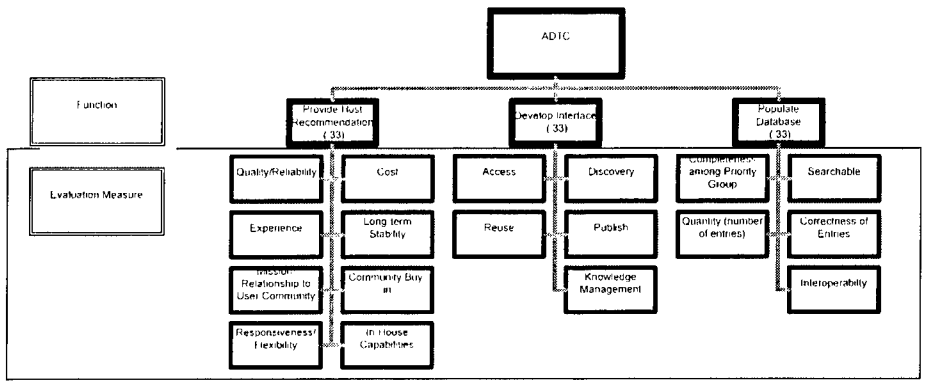
DMSO



https://www.dmso.mil/public/

Slide 39

Core Function Evaluation Measures



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14. ABSTRACT
Used to improve military effectiveness, enhance warfighting readiness, and reduce operating costs, simulations have become commonplace in nearly all areas of the U.S. Armed Forces. From material acquisition to force structure analysis, from first-person video-game shooters to network-centric battle staff exercises, simulations have progressed into becoming intrinsic components of nearly all aspects of the military landscape. As the military has become more accustomed to using simulations and its expectations have grown about simulation capabilities, the demand and need for more realistic virtual and constructive environments have increased. Accordingly, there have been escalating demands on the modeling and simulation (M&S) community to incorporate greater fidelity and resolution of the natural and manmade environment and systems interaction in the battlespace to make the simulation experience increasingly more realistic and complete. Unfortunately, this has increased the cost of developing simulations and their associated terrain databases, both in terms of price as well as time. This report documents how the Operations Research Center of Excellence at the U.S. Military Academy has employed systems engineering principles to help address the rising cost of M&S development. Specifically, this report discusses the design and development of the Army Digital Terrain Catalog (ADTC) to help promote discovery, accessibility, and reuse of digital terrain databases.

15. SUBJECT TERMS
Simulation Terrain Databases, Product Development, Information Technology, Transformation

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